
Space Weather Technical Forecast

Issued on Sunday, 21 July 2024 at 13:01 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: M-class flares Likely. Chance of G1 Minor Storms peaking Day 3 (23 July).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has remained Moderate, with GOES16 recording occasional low-level M-class flares from AR3744 in the northwest, peaking at or very near M1.5 at 20/1849UTC, 21/0355UTC and a third from AR3751 at 21/0834UTC. The sunspot group responsible for much of the activity - AR3744 - became increasingly difficult to classify, however there has been lot of movement and shear in this group, which may go some way to explaining its recent activity, despite apparently not being the most complex group on the disc as a Dai/BG.

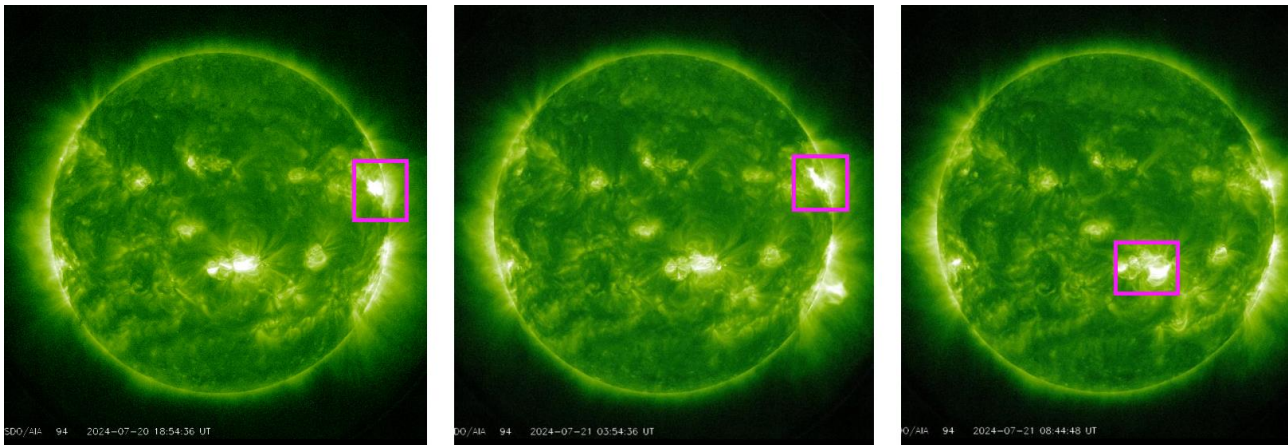


Figure 0: AIA094 extreme UV imagery showing the source regions for the three M-class flares of the period, respectively two from AR3744 and the third from AR3751. At the time of writing only the middle event was confirmed as having generated any CME, albeit not Earth-directed in this case.

There are currently up to eleven sunspot regions on the visible disc, with AR3745 and AR3752 no longer discernible. The main changes in the period have included emergence of further trailing spots in AR3751, with the persistence of Mt Wilson delta spots in its central portion. To its immediate east, AR3761 showed spreading, emergence of spots and maturing penumbrae to become a Zurich compact group. A more minor growth trend was visible in AR3757's trailing spots in the northeast, while AR3759 showed the opposite tendency in fading slightly in the west.

There was no evidence of Earth-directed Coronal Mass Ejections (CMEs) in the period. Coronagraph imagery shows faint ejecta directed to the far southeast from a prominence eruption here around the turn of the current UTC day, and also ejecta heading well westward from AR3744 from its 21/0355UTC flare. Other minor activity is currently thought to have originated from behind the solar limbs, all to no effect on the forecast.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

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Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE at L1, showed a continuation of a slow regime. The speed, density and IMF were all within normal Background ranges: from 375 to 325km/s; single figures ppcc and declining from 6nT respectively. The north-south component of the IMF was also subdued with a range of between +5 and -4nT, while the phi angle was negative (towards the Sun) after 20/1330UTC.

The net result of the above solar wind measures was for provisionally mainly Quiet geomagnetic indices, but with an Unsettled peak of '3-' in the 15-18UTC interval.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at Background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background. The 24-hour fluence was well below Active, with 9.31e5 integrated pfu observed at 21/0001UTC.

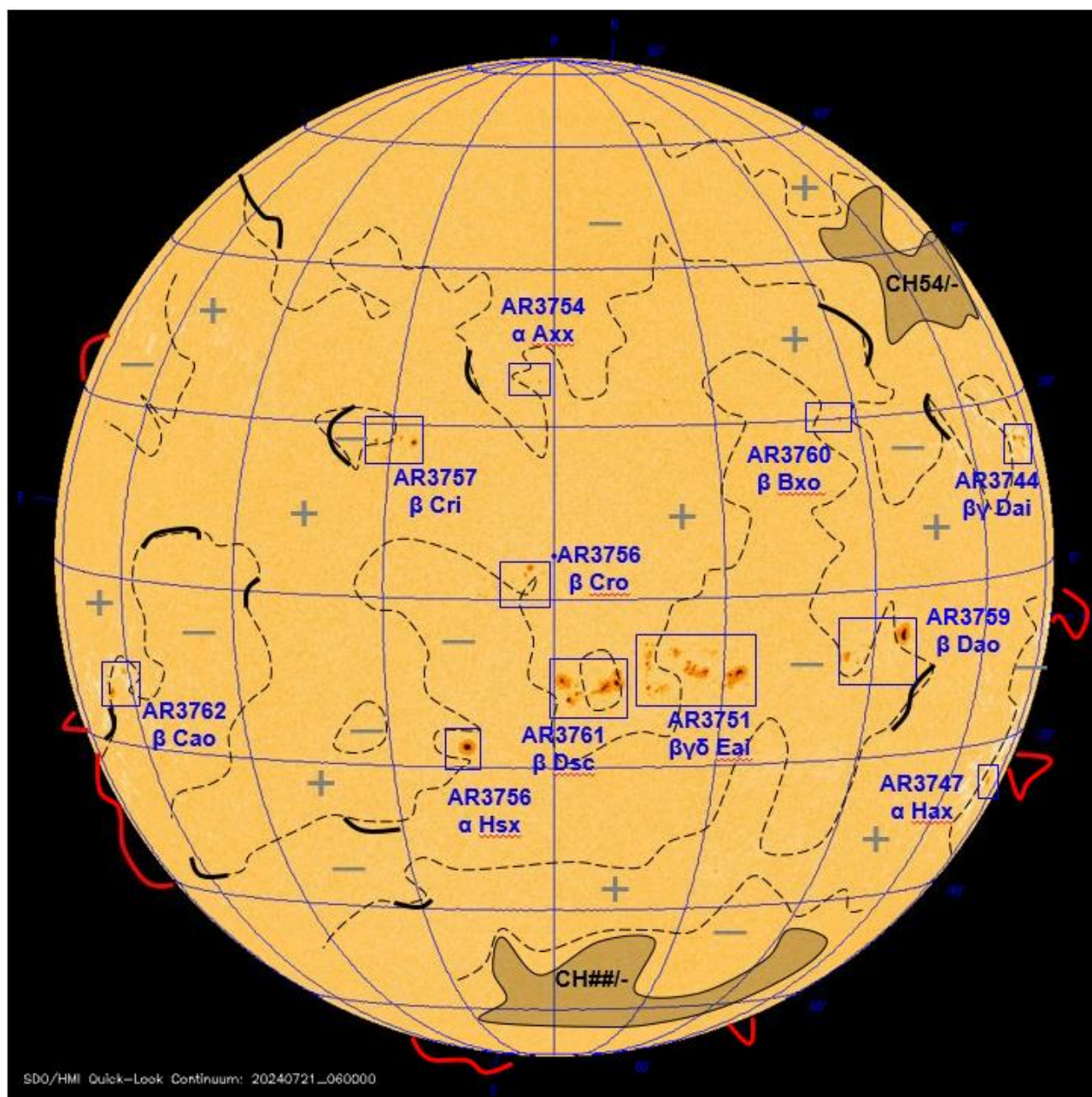
Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Likely throughout, perhaps falling slightly into day three (23 July) as the most active region of recent hours passes onto the far side.

Solar Wind /Geomagnetic Activity: One CME from 19 July - a south central filament eruption - now features in the forecast, giving a peak Chance of Minor Geomagnetic Storm G1 conditions on day three, Tuesday 23 July. No fast winds feature, and activity should otherwise remain Quiet throughout.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at Background levels, but with a Slight Chance of rising above the S1/Minor Storm threshold in response to any notable flares from AR3744 or perhaps AR3751. High energy electron flux is expected to remain at Normal Background levels, with no obvious mechanism for their enhancement and any Active fluence.

Figure 1. Solar Analysis Valid 21/0600UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No fast winds and one CME now feature in the forecast. The CME is a south-central filament eruption that left the Sun on Friday 19 July. This is due to cross 1AU within the UTC day of Tuesday 23 July and brings with it a Chance of Minor Geomagnetic Storm G1 conditions - the peak for the period in an otherwise entirely Quiet four days.

MOSWOC Enlil modelling and its associated ensemble places this arrival fairly centrally within

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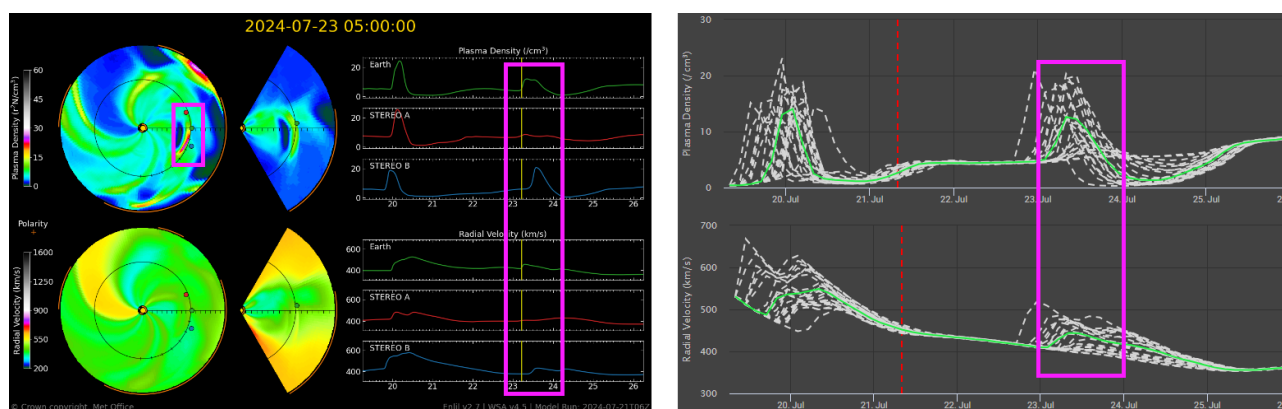
that UTC day such that any effects ought to be relatively well-contained to Tuesday. The intervening modelled solar wind speed is evidently a little fast, as the 16 July CMEs failed to materialise at Earth which may mean some of the later ensemble members are more representative of the arrival of the 19 July CME, hence a weak residual G1 tail into day four, Wednesday 24 July.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	40	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/0400	Partial	Filament eruption	S-Centre	615 km/s	23/0800 UTC +/- 9 hrs	Northern portion of filament eruption, second of the two

Figure 2: Latest MOSWOC Enlil run (badge time 21/0600UTC), paused at the 1AU crossing time of the 19 July south-central filament CME, now the only one remaining inbound in the forecast. Note that this Enlil run is polluted by the erroneous forecast for the 16 July CMEs, which may have acted to falsely clear the interplanetary medium in model-space to provide minimal hindrance to this later 19 July CME. The result is that, while still likely arriving within the UTC day of 23 July, those slightly later-skewed ensemble members are perhaps more reflective of any arrival at Earth.

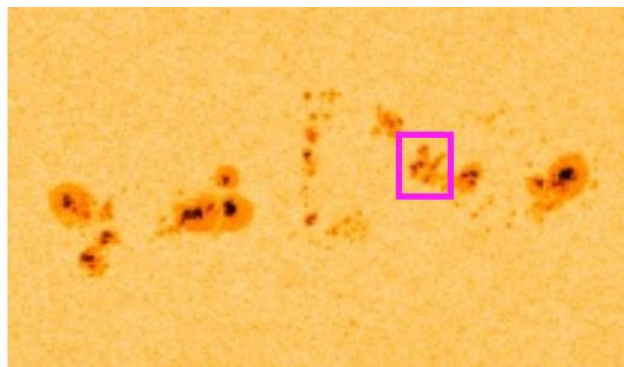
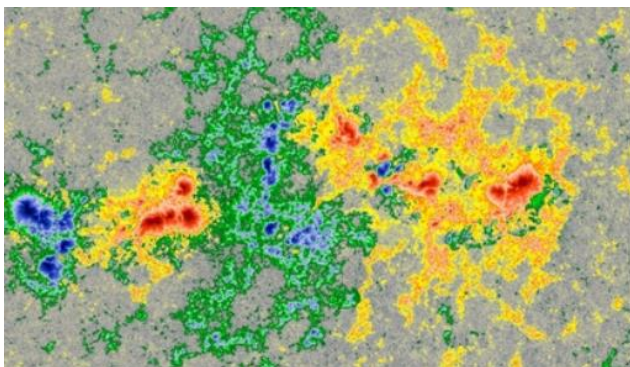


Radio Blackouts - X-Ray Flares:

With the possible exceptions of imminent arrival of Ex-AR3731 and Ex-AR3733 over the eastern solar horizon (possibly visible as flux looping in AIA171), the current cohort of front-sided regions should provide the peak population for the period, and a gradual decrease is otherwise expected over the four days. Most relevantly, the most active region of the past 36 hours or so, AR3744 in the northwest should depart the Earth-facing side on day three, Tuesday 23 July, leading to a step-wise slight decrease in the risks of further M-class flares, with the bulk of the residual risk then shouldered by AR3751 and perhaps AR3761 nearer centre-disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: HMIBC and HMIIF imagery valid at 21/1130UTC showing AR3761 and AR3751 near centre-disc. The latter was responsible for one of the M-class flares of the period, and can be seen to retain a Mt Wilson delta spot in its intermediate portion.



Solar Radiation Storms - (High Energy Protons):

GOES18 proton flux remains at Background levels, despite potentially generative flares from near the western limb emanating from AR3744 in the past 24 hours.

The probability of events breaching S1 increases very slightly over time as AR3744 and some of the more complex centre-disc regions move into the better-connected solar western hemisphere, where high energy protons have a greater likelihood of reaching Earth via the Parker Spiral. AR3744 itself should cross onto the far side around day three, 23 July, however it will retain some presence in terms of S1 risk for the remainder of the period, with its contribution decreasing as that from AR3751's increases.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	15	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm ⁻² sr ⁻¹ s ⁻¹)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux as observed by GOES16 is currently at Normal Background and is expected to persist at this level given the lack of any notable sources of enhancement in the period. The CME that is expected to arrive on Day 3 (23 July) has the potential to eventually increase counts in the Van Allen belts however intervening geomagnetic activity should place any increase outside the current forecast period.

GEO Electron Environment	Level (cm ⁻² sr ⁻¹ day ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1